REMARKS

Applicants respectfully request reconsideration of the application in view of the following remarks.

Claims 1, 3-13 and 15-22 are pending in the application.

Claims 1, 3, 4, 7-9, 11-13 and 15-19 were rejected under 35 U.S.C. § 102(b) as being anticipated by Yu et al., "Two-Dimensional Motion Vector Coding for Low Bitrate Videophone Applications" ("Yu"). Claims 5, 6 and 10 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Yu.

Applicants respectfully add claims 20-22.

1) <u>The disclosure has been amended to correct errors of a minor, typographical nature.</u>

The paragraph beginning at page 5, line 18 of the specification has been amended to correct an error of a minor, typographical nature. At line 19, "accompany" has been replaced with "accompanying."

2) <u>The Yu reference</u>

Yu describes jointly coding horizontal and vertical differential motion vector ("DMV") components. [*See* Yu at page 414.] Yu describes the range of possible DMV values (in half-pixel steps) as being greater than or equal to -31.5 pixels, and less than or equal to 31.5 pixels. [*See* Yu at page 415.] Yu places all possible DMV values in a square reaching from -31.5 to 31.5 on both the x and y axis. [*See* Yu at page 415.] The square is divided into three regions: Region A is the square reaching from -8 to 8 on both the x and y axis; Region B is the square reaching from -16 to 15.5 on the x and y axis minus the area of Region A; Region C covers the remainder of the area. [*See* Yu at page 415.]

Yu states that most DMVs fall into Region A because the frequency of occurrence for small DMVs is very high. [*See* Yu at page 415.] A variable length code table consisting of variable length codes ("VLCs" or "codes") for pairs of x and y components in Region A is generated. [*See* Yu at page 415.] The table contains 290 codes representing each of the possible pairs of absolute DMV values from 0 to 8 in Region A, in half-pixel steps (17 half-pixel steps x 17 half-pixel steps + 1 escape code). [*See* Yu at page 415.] *Yu's method assumes that each and*

every pair in Region A is more likely to occur than any pair in Regions B or C. The escape code is used to encode DMV values in Region B. [*See* Yu at pages 415-16.] DMV values in Region C share the same codes with DMV values in Region A or B, but incorporate an offset of ±32.0 pixels to distinguish the Region C code from the Region A or B code. [*See* Yu at page 416.]

After the pairs to be represented in the VLC table are known, Yu then determines the VLCs to be assigned to the pairs, respectively. Yu does not use the actual results of running five test sequences (e.g., the histogram representing the actual frequencies in the test sequences of the DMV pairs) to determine the VLCs. [*See* Yu at page 417.] Instead, Yu sees the "slight irregularity in the actual histogram from a finite training set of video sequences" as a "problem":

> The problem can be solved by first smoothing the irregular histogram and then generating the Huffman VLCs that more closely match the *theoretical* results. The VLCs we used [were] actually generated from the smoothed histogram where irregularity had been removed.

[*See* Yu at page 417 (emphasis added).] Thus, Yu relies on "theoretical" results to determine the VLCs for the VLC table.

3) <u>Yu fails to teach or suggest at least one element of each of claims 1, 7, 11, 13, 16 and 19.</u>

Previously, claims 1, 7, 11, 13, 16 and 19 were rejected as being anticipated by Yu under 35 U.S.C. § 102(b). Yu fails to teach or suggest at least one element of each of claims 1, 7, 11, 13, 16 and 19.

a) <u>Yu fails to teach or suggest "the table includes the most probable pairs of joint differential motion vector components as computed by statistical analysis of example video sequences" as recited in claim 1.</u>

Claim 1 recites "the table includes the most probable pairs of joint differential motion vector components as computed by statistical analysis of example video sequences." According to claim 1, x and y motion vector components are predicted for a current block of pixels based on a motion vector of at least one neighboring block of pixels to compute x and y components of a predictor motion vector. Differential x and y components are computed from the x and y components of the predictor and x and y components of a motion vector for the current block. A single variable length code from a variable length code table is assigned to joint x and y differential motion vector components. The table comprises a list of pairs of joint differential motion vector components and a corresponding variable length code for each pair, such that

shorter variable length codes are assigned to joint differential motion vector components that have a higher probability of occurrence in the video images, and longer variable length codes are assigned to joint differential motion vector components that have a lower probability of occurrence. The table includes the most probable pairs of joint differential motion vector components as computed by statistical analysis of example video sequences.

As explained above, Yu's method of creating a variable length coding table for pairs of differential motion vector components *assumes* that each and every pair in Region A is more likely to occur than any pair in Regions B or C. The pairs represented in the Yu's VLC table are determined *before conducting any statistical analysis or training*. In Yu, the statistical analysis is done to determine VLCs for the *already selected* pairs of differential motion vectors. Thus, Yu does not teach or suggest, "the table includes *the most probable pairs* of joint differential motion vector components *as computed by statistical analysis of example video sequences*," as recited in claim 1.

Furthermore, Yu leads away from the above-cited language of claim 1. Yu describes altering a histogram representing actual test results (e.g., actual frequencies of pairs of joint differential motion vector components) by relying on "theoretical" results to remove "irregularity." [*See* Yu at page 417.] "Smoothing" the histogram addresses the "irregularity" by altering the measured frequencies of the pairs of joint differential motion vector components in order to conform to a previously conceived "theoretical" model, rather than by changing the constituent pairs of the VLC table. Thus, Yu leads away from the above-cited language of claim 1.

Claim 1 is allowable. As a result, the separate patentability of dependent claims 3-6 need not be addressed at this point. Claims 1 and 3-6 are allowable. Such action is respectfully requested.

b) Yu fails to teach or suggest "wherein training determines which x and y components to include in the entropy codebook," as recited in claim 7.

Claim 7 recites "wherein training determines which x and y components to include in the entropy codebook." According to claim 7, a single variable length code representing joint x and y components of a motion vector for each of plural macroblocks is received. For each of the macroblocks, a single entry in an entropy codebook is searched for. The entry corresponds to the variable length code and includes the x and y components of the motion vector. Training determines which x and y components to include in the entropy codebook. The x and y

components of the motion vector from the codebook are used to define motion of pixels in a corresponding macroblock.

As explained above, Yu's method of creating a variable length coding table for pairs of differential motion vector components *assumes* that each and every pair in Region A is more likely to occur than any pair in Regions B or C. The pairs represented in Yu's VLC table are determined *before conducting any statistical analysis or training*. In Yu, the statistical analysis is done to determine VLCs for the *already selected* pairs of differential motion vectors. Thus, Yu does not teach or suggest "wherein training determines which x and y components to include in the entropy codebook."

Furthermore, Yu addresses an "irregularity" in a histogram by altering the measured frequencies of the pairs of joint differential motion vector components, rather than by changing the constituent pairs of the VLC table, which leads away from the above-cited language of claim 7.

Claim 7 is allowable. As a result, the separate patentability of dependent claims 8-10 need not be addressed at this point. Claims 7-10 are allowable. Such action is respectfully requested.

c) Yu fails to teach or suggest "wherein statistical analysis indicates which differential motion vector components to represent with variable length codes and which differential motion vector components to represent with an escape code followed by fixed length codes," as recited in claim 11.

Claim 11 recites "wherein statistical analysis indicates which differential motion vector components to represent with variable length codes and which differential motion vector components to represent with an escape code followed by fixed length codes." According to claim 11, a motion vector encoder comprises a motion vector predictor for computing a motion vector predictor for a motion vector of a block of pixels from at least one motion vector for a neighboring block of pixels. The motion vector encoder also comprises a subtractor for computing differential motion vector components from motion vector components of the predictor and the motion vector of the block of pixels, and a joint entropy coder for jointly coding the differential motion vector components with a single variable length code. Statistical analysis indicates which differential motion vector components to represent with variable length codes and which differential motion vector components to represent with an escape code followed by fixed length codes.

As explained above, Yu's method of creating a variable length coding table for pairs of differential motion vector components *assumes* that each and every pair in Region A is more likely to occur than any pair in Regions B or C. The pairs represented in Yu's VLC table are determined *before conducting any statistical analysis or training*. In Yu, the statistical analysis is done to determine VLCs for the *already selected* pairs of differential motion vectors. Thus, Yu does not teach or suggest "wherein statistical analysis indicates which differential motion vector components to represent with variable length codes and which differential motion vector components to represent with an escape code followed by fixed length codes."

Furthermore, Yu addresses an "irregularity" in a histogram by altering the measured frequencies of the pairs of joint differential motion vector components, rather than by changing the constituent pairs of the VLC table, which leads away from the above-cited language of claim 11.

Claim 11 is allowable. As a result, the separate patentability of dependent claim 12 need not be addressed at this point. Claims 11-12 are allowable. Such action is respectfully requested.

d) Yu fails to teach or suggest "wherein training determines which joint differential motion vector components to include in the table and which joint differential motion vector components to exclude from the table" as recited in claim 13.

Claim 13 recites, "wherein training determines which joint differential motion vector components to include in the table and which joint differential motion vector components to exclude from the table." According to claim 13, a motion vector decoder comprises a motion vector predictor for computing a motion vector predictor for a motion vector of a block of pixels from at least one motion vector for a neighboring block of pixels. The motion vector decoder also comprises a joint entropy encoder for decoding a single variable length code into joint differential motion vector components. The joint entropy decoder decodes the single variable length code by searching for the code in a Huffman coding table comprising a list of variable length codes and corresponding joint differential motion vector components for each of the variable length codes. Training determines which joint differential motion vector components to include in or exclude from the table. The motion vector decoder also comprises an adder for reconstructing x and y motion vector components from the joint differential motion vector components and x and y components of the motion vector predictor.

As explained above, Yu's method of creating a variable length coding table for pairs of differential motion vector components *assumes* that each and every pair in Region A is more likely to occur than any pair in Regions B or C. The pairs represented in Yu's VLC table are determined *before conducting any statistical analysis or training*. In Yu, the statistical analysis is done to determine VLCs for the *already selected* pairs of differential motion vectors. Thus, Yu does not teach or suggest "wherein training determines which joint differential motion vector components to include in the table and which joint differential motion vector components to exclude from the table."

Furthermore, Yu leads away from the above-cited language of claim 13. Yu describes altering a histogram representing actual test results (e.g., actual frequencies of pairs of joint differential motion vector components) by relying on "theoretical" results to remove "irregularity." [*See* Yu at page 417.] "Smoothing" the histogram addresses the "irregularity" by altering the measured frequencies of the pairs of joint differential motion vector components in order to conform to a previously conceived "theoretical" model, rather than by changing the constituent pairs of the VLC table. Thus, Yu leads away from the above-cited language of claim 13.

Furthermore, Yu addresses an "irregularity" in a histogram by altering the measured frequencies of the pairs of joint differential motion vector components, rather than by changing the constituent pairs of the VLC table, which leads away from the above-cited language of claim 13.

Claim 13 is allowable. As a result, the separate patentability of dependent claim 15 need not be addressed at this point. Claims 13 and 15 are allowable. Such action is respectfully requested.

e) <u>Yu fails to teach or suggest "wherein training determines which joint x and y motion vector components to represent in the set of available variable length codes" as recited in claim 16.</u>

Claim 16 recites "wherein training determines which joint x and y motion vector components to represent in the set of available variable length codes." According to claim 16, x and y motion vector components are computed for a block. The x and y motion vector components are formed into a joint parameter representing joint x and y motion vector components. A single variable length code is assigned to the joint x and y motion vector components. The single variable length code is selected from a set of available variable length

codes, such that shorter variable length codes are assigned to joint motion vector components that have a higher probability of occurrence in the video images. Longer variable length codes are assigned to joint differential motion vector components that have a lower probability of occurrence. Training determines which joint x and y motion vector components to represent in the set of available variable length codes.

As explained above, Yu's method of creating a variable length coding table for pairs of differential motion vector components *assumes* that each and every pair in Region A is more likely to occur than any pair in Regions B or C. The pairs represented in Yu's VLC table are determined *before conducting any statistical analysis or training*. In Yu, the statistical analysis is done to determine VLCs for the *already selected* pairs of differential motion vectors. Thus, Yu does not teach or suggest "wherein *training* determines which joint x and y motion vector components to represent in the set of available variable length codes."

Furthermore, Yu addresses an "irregularity" in a histogram by altering the measured frequencies of the pairs of joint differential motion vector components, rather than by changing the constituent pairs of the VLC table, which leads away from the above-cited language of claim 16.

Claim 16 is allowable. As a result, the separate patentability of dependent claims 17-18 need not be addressed at this point. Claims 16-18 are allowable. Such action is respectfully requested.

f) <u>Yu fails to teach or suggest "wherein the Huffman table includes variable length codes for the most probable joint differential x and y components as computed by statistical analysis of example video sequences" as recited in claim 19.</u>

Claim 19 recites "wherein the Huffman table includes variable length codes for the most probable joint differential x and y components as computed by statistical analysis of example video sequences." According to claim 19, a single variable length code is received representing joint differential x and y components of a motion vector for each of plural macroblocks. For each of the macroblocks, a single entry in a Huffman table is searched for. The single entry corresponds to the variable length code and includes the joint differential x and y components of the motion vector. The Huffman table includes variable length codes for the most probable joint differential x and y components as computed by statistical analysis of example video sequences. X and y components of a predictor motion vector are computed from neighboring macroblocks

to the macroblock currently being decoded. The motion vector is reconstructed from the differential components obtained from the Huffman table and the x and y components of the predictor motion vector.

As explained above, Yu's method of creating a variable length coding table for pairs of differential motion vector components *assumes* that each and every pair in Region A is more likely to occur than any pair in Regions B or C. The pairs represented in Yu's VLC table are determined *before conducting any statistical analysis or training*. In Yu, the statistical analysis is done to determine VLCs for the *already selected* pairs of differential motion vectors. Thus, Yu does not teach or suggest "wherein the Huffman table includes variable length codes *for the most probable joint differential x and y components as computed by statistical analysis* of example video sequences."

Furthermore, Yu addresses an "irregularity" in a histogram by altering the measured frequencies of the pairs of joint differential motion vector components, rather than by changing the constituent pairs of the VLC table, which leads away from the above-cited language of claim 1.

Claim 19 is allowable. Such action is respectfully requested.

4) <u>Applicants respectfully add claims 20-22.</u>

Applicants respectfully add claims 20-22. Claim 20 recites "wherein training determines which joint x and y motion vector components to represent in the set of available variable length codes." [*See*, *e.g.*, Application, pages 10-12.] Claim 22 recites, "wherein the Huffman table includes variable length codes for the most probable joint differential x and y components as computed by statistical analysis of example video sequences." [*See*, *e.g.*, Application, pages 10-12.]

Claims 20-22 should be allowable. Such action is respectfully requested.

CONCLUSION

The claims in their present form should now be allowable. Such action is respectfully requested.

REQUEST FOR INTERVIEW

If the Examiner finds that the amendment does not make the application allowable, the Examiner is formally requested to contact the undersigned attorney at (503) 226-7391 prior to issuance of the next communication in order to arrange a telephonic interview. It is believed that a brief discussion of the merits of the present application will allow the application to be passed to issue. Applicant submits the foregoing remarks so that the Examiner may fully evaluate Applicant's position, thereby enabling the interview to be more productive.

This request is being submitted under MPEP § 713.01, which indicates that an interview may be arranged in advance by a written request.

Respectfully submitted,

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APPENDIX

Marked-up Version of the Amended Specification and Claims

In the Specification:

Amended paragraph beginning at page 5, line 18:

Additional features of the invention will become more apparent from the following detailed description and [accompany] **accompanying** drawings.

In the Claims:

4. (Twice Amended) The method of claim 1 wherein the block of pixels corresponds to a macroblock in a video frame divided into fixed-sized, rectangular macroblocks, and the predicting, computing, and assigning are repeated for the macroblocks in the video frame.

5. (Twice Amended) The method of claim 1 wherein the block of pixels corresponds to a macroblock of a video object plane in a video frame having two more video object planes, and the video object planes are each divided into fixed-sized, rectangular macroblocks; and

the predicting, computing and assigning are repeated for the macroblocks in the video object planes.

20. (New) In a video coder for coding video images in a block format, a method for variable length coding block motion information of the video images, wherein a joint parameter represents x and y motion vector components for a block, the method comprising:

assigning a single variable length code selected from a set of available variable length codes to the joint x and y motion vector components, wherein training determines which joint x and y motion vector components to represent in the set of available variable length codes.

21. (New) The method of claim 20 wherein the block is a 16x16 macroblock of pixels, and wherein each of the x and y motion vector components comprises a differential value.

22. (New) A video decoder including computer-executable instructions for causing a computer programmed thereby to perform a method for variable length decoding macroblock motion information of a predicted video frame, wherein a single variable length code represents joint differential x and y components of a motion vector for each of plural macroblocks, the method comprising:

for each of the plural macroblocks, searching for a single entry in a Huffman table corresponding to the variable length code for the macroblock, wherein the single entry includes the joint differential x and y components of the motion vector for the macroblock, wherein the joint differential x and y components are combinable with predictor x and y components to reconstruct the motion vector for the macroblock, and wherein the Huffman table includes variable length codes for the most probable joint differential x and y components as computed by statistical analysis of example video sequences.